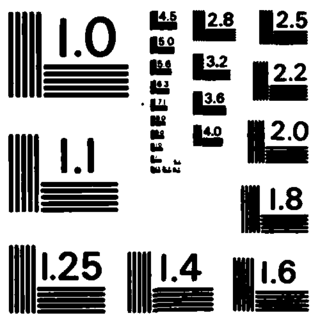
AD-A132 748 SPATIAL LOCALIZATION IN STRABISMIC OBSERVERS(U) 1/1
COLUMBIA UNIV NEW YORK DEPT OF PSYCHOLOGY L MATIN
10 JUN 83 NADC-83049-60 N62269-82-M-3208

UNCLASSIFIED F/G 6/16 NL

END
DATE
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(12)

REPORT NO. NADC-83049-60

AD-A132 748

SPATIAL LOCALIZATION IN STRABISMIC OBSERVERS

Dr. Leonard Matin
Visual Science Laboratory, Dept. of Psychology
COLUMBIA UNIVERSITY
New York, NY

10 JUNE 1983

PHASE REPORT
Contract No. N62269-82-M-3208

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Prepared for
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, PA 18974

NOTICES

REPORT NUMBERING SYSTEM – The numbering of technical project reports issued by the Naval Air Development Center is arranged for specific identification purposes. Each number consists of the Center acronym, the calendar year in which the number was assigned, the sequence number of the report within the specific calendar year, and the official 2-digit correspondence code of the Command Office or the Functional Directorate responsible for the report. For example: Report No. NADC-78015-20 indicates the fifteenth Center report for the year 1978, and prepared by the Systems Directorate. The numerical codes are as follows:

CODE	OFFICE OR DIRECTORATE
00	Commander, Naval Air Development Center
01	Technical Director, Naval Air Development Center
02	Comptroller
10	Directorate Command Projects
20	Systems Directorate
30	Sensors & Avionics Technology Directorate
40	Communication & Navigation Technology Directorate
50	Software Computer Directorate
60	Aircraft & Crew Systems Technology Directorate
70	Planning Assessment Resources
80	Engineering Support Group

PRODUCT ENDORSEMENT – The discussion or instructions concerning commercial products herein do not constitute an endorsement by the Government nor do they convey or imply the license or right to use such products.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NADC-83049-60	2. GOVT ACCESSION NO. AD-A132 745	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Spatial Localization in Strabismic Observers		5. TYPE OF REPORT & PERIOD COVERED Phase Report 10 Jun 82-10 Jun 83
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Leonard Matin, Ph.D.		8. CONTRACT OR GRANT NUMBER(s) N62269-82-M-3208
9. PERFORMING ORGANIZATION NAME AND ADDRESS Visual Science Laboratory, Dept. of Psychology Columbia University New York, NY 10027		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Air Systems Command Washington, D.C. 20361		12. REPORT DATE 10 June 1983
		13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Air Development Center Warminster, PA 18974		15. SECURITY CLASS. (of this report) Uncl.
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Spatial Localization
Strabisma
Vision
EEPI

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is an investigation of the way in which extraretinal eye position information (EEPI) is involved in the determination of localization and the possibility of flexibility and/or adaptation in the relation between the retinal image location (RI) and EEPI.

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DISCUSSION

The individual perceiver is not directly informed about the actions of two of the three muscular systems which operate to optimize various properties of his retinal image for visual perception. Pupil size and lens shape are themselves controlled within closed loops in which particular attributes of the retinal image (and perhaps of perception itself) serve as the basis for servo signals: -- some aspect of the quantity of illumination is used to control pupil size in the interest of optimizing the tradeoff between quantum catch and image quality; some function of image clarity is employed to control lens shape. But direct information about neither pupil size nor lens shape enters visual perception at all. For example, the accommodative state does not provide a cue to depth perception -- although, in principle, it could -- nor is pupil size even a reasonable possibility as a cue to perception for anything at all.

This lack of information regarding the actions of the pupil and lens is in marked contrast to the eye movement control system, where quite a different story holds for the consequences of the actions of the extraocular muscles. Although for some classes of eye movements the extraocular muscles also may act under closed loop control, direct open loop information about the action of the extraocular muscles not derived from effects on the retinal image are essential for visual perception, if only for the obvious reason shown in Figure 1 -- namely, that an observer foveating the visual target (in a) would have an identical change in retinal image location produced by target movement through angle θ (in b) and by an eye movement through angle θ (in c). It is essential that the observer perceive matters differently in (b) and (c), and for this purpose it has seemed essential to have a channel of information that can signal the change of eye position separately from the channel of information that signals retinal location. In the same vein, it is also desirable that the observer be able to perceptually derive the spatial location of visible objects from information regarding their retinal image location. But, this too cannot be done from retinal image location alone any more than one can derive the location of an object in a room from the location of the image of the object on a film's image of the room taken by a camera. However, if the orientation of the camera relative to the room is also given as a separate piece of information, it becomes possible to derive the location of the object relative to the room.

Thus, it has seemed obvious that our visual localizations of visible objects must be obtained by combining information about retinal image location (RI) and extraretinal information about eye position relative to the orbit (EEPI). The particular combination of RI and EEPI that relates the two by a neural subtraction process is the Cancellation Theory and is represented in Figure 2.

(Although it will not be pursued here, it is worth noting that Cancellation Theory comes in three forms (Figure 3): Inflow Theory puts the source of EEPI in receptors in the orbit; Outflow Theory puts the source of EEPI in the command to turn the eye, and the Hybrid Theory puts the source in the orbit but modulates the inflow by means of outflow. Which of these versions is correct is not yet known (Matin, 1972, 1982).

In last year's Final Technical Report (Matin, 1982a) I described how we were able to conclude -- largely from our experiments with experimentally paralyzed eyes of human observers -- that the cancellation mechanism is the basis for visual localization in darkness, as well as a most important basis for intersensory localization in a normally illuminated environment and in darkness, but that in a normally illuminated environment visual localization was not itself normally influenced by the cancellation mechanism. Instead, in a normally illuminated environment the involvement of the cancellation mechanism in visual localization was suppressed.

Thus, in order to study the relation of EEPI and the cancellation mechanism to spatial localization in the absence of such suppression, the situations of first choice include (1) studying visual localization in darkness; (2) studying intersensory localization in darkness; (3) studying intersensory localization in a normally illuminated environment. We have studied all three. In addition, some specific theoretical interests regarding the relation of cancellation to localization has led us to investigate localization in strabismic observers. These interest include (1) an attempt to determine

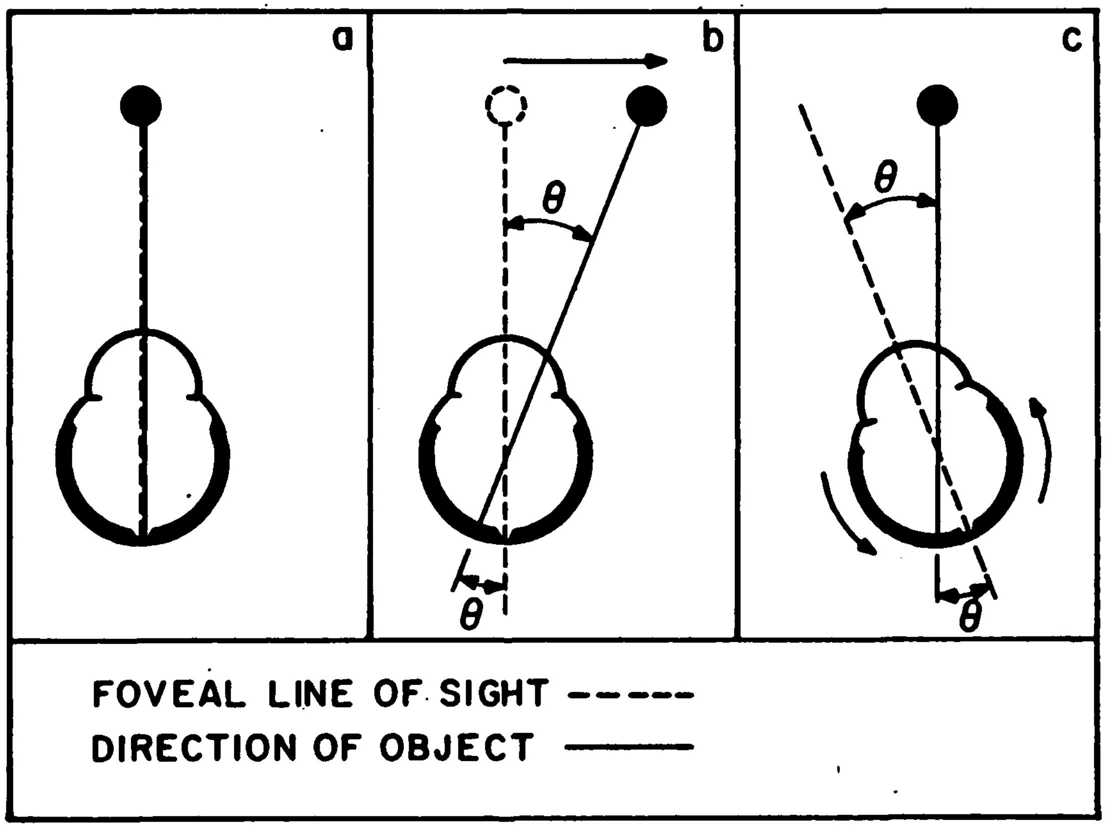


Figure 1. Identical Shifts In Stimulus Retinal Location Are Produced By An Ocular Rotation Or Stimulus Displacement Through An Angle

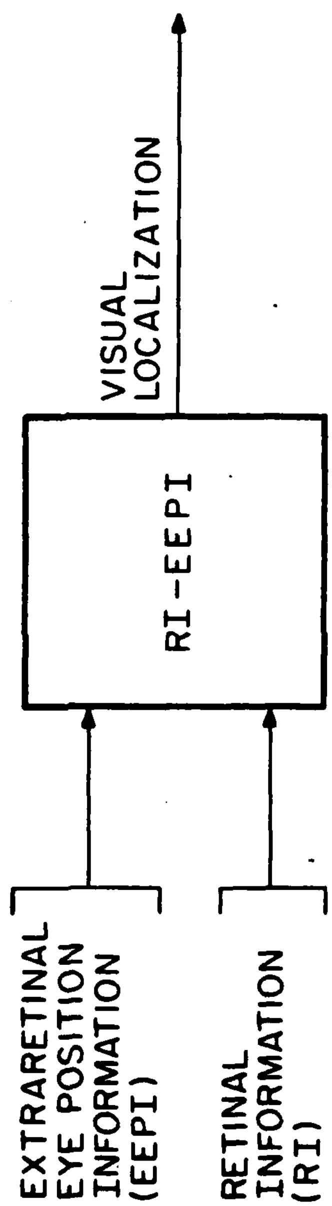


Figure 2. Cancellation Model

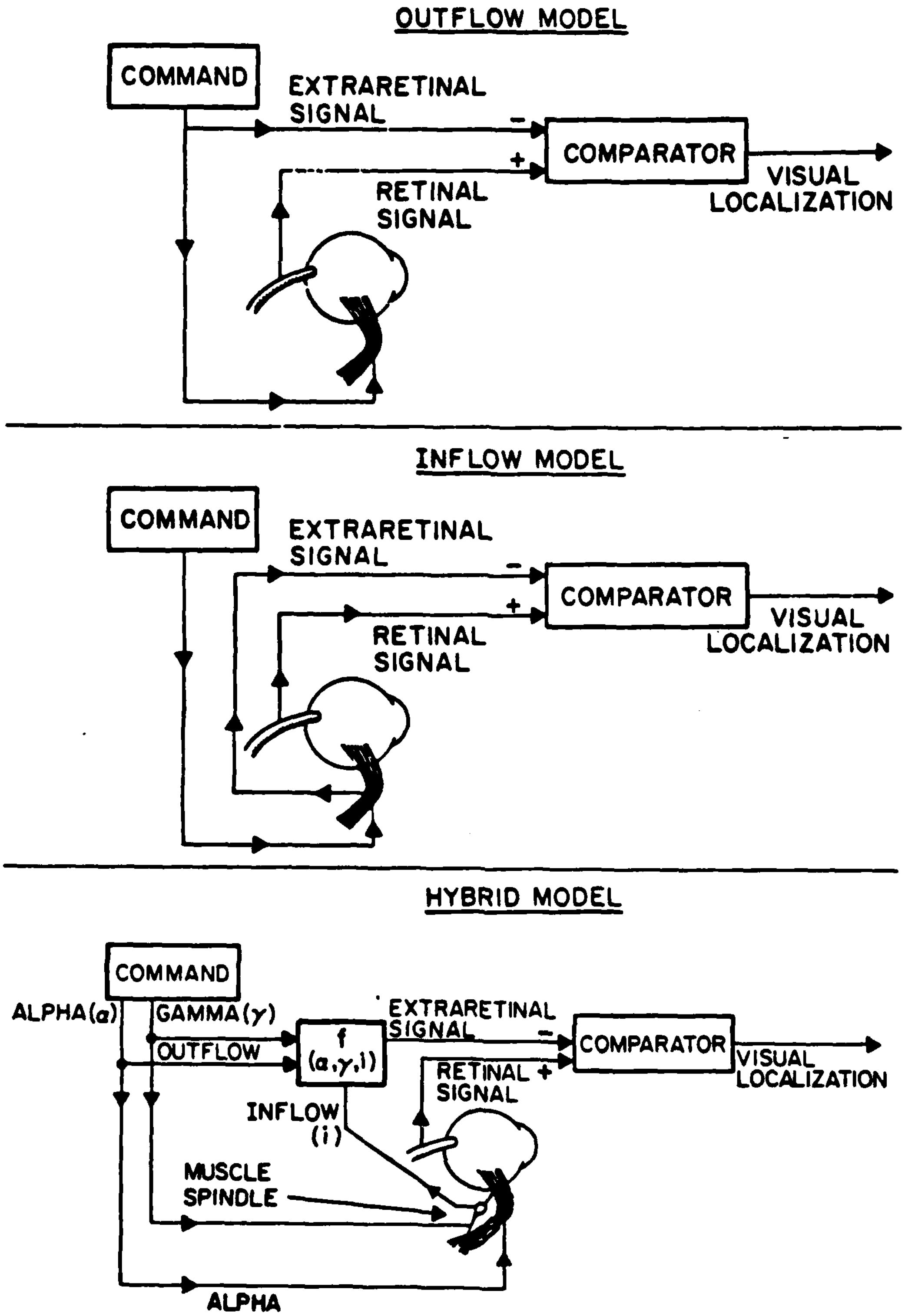


Figure 3. Three Versions Of Cancellation Model

from psychophysical experiments which of the two neural circuits (in Figure 4) for cancellation-mediated localization was true, and (2) an interest in determining which of t.e two models in Figure 5 (Figure 5a; Figure 5b) described the way in which EEPI was involved in the determination of localization with the two eyes. (3) An additional interest that led us to work with strabismic observers was concern with the possibility of flexibility and/or adaptation in the relation between RI and EEPI. Strabismic observers provide a singularly useful anomoly for dealing with these three focal interests. The experiments to be described below deal particularly with (2) and (3).

Figure 6 shows the strabismic observer (viewed from above) monocularly viewing a light with the left eye when the right eye is ocluded (left side of figure), and also monocularly viewing the same light with the right eye when the left eye is ocluded (right side of figure). The angle α is the angle of strabismic deviation. If the EEPI employed in localizing the light for each of the two viewing conditions in Figure 6 is the same (model in Figure 5a; "localization with unitary binocular EEPI")-the difference in localizing the light between the two conditions should be equal to the difference in ocular posture between the two conditions -- that is, equal to the angle α. Strabismics with different deviations should thus show differences in localizations between the two eyes that should be simply related to the size of the strabismic deviation. If localization was mediated via the "unitary binocular EEPI" as in Figure 5a then this difference in localizations between the two eyes should hold when the visual target A is presented at any eccentricity, not just in the median plane as shown in Figure 5.

On the other hand, if the EEPI employed in localizing the visual target in Figure 6 was not the same when localization was with the left eye viewing as when localization was with the right eye viewing -- that is, if EEPI is separate and different when viewing with one eye as compared to when viewing with the other eye (model in Figure 5b; "localization with independent monocular EEPI), then the difference in localizations with the two eyes of a strabismic observer need not be equal to the strabismic deviation. Specifically then, if the difference in localizations between the two eyes of strabismic observers is unrelated to the magnitude of the strabismic deviation then one could conclude that EEPI employed for localizing with one eye was independent of EEPI employed for localizing with the other eye. A result in which the relation between strabismic deviation and localization difference between the two eyes was neither complete nor entirely absent would indicate some linkage between the EEPI employed when the left eye was viewing alone and when the right eye was viewing alone.

As a means of measuring visual localization we employed a localization match between the fixated visual target and a sound whose location within the horizontal plane was variable. This localization match was carried out by each of 23 strabismic observers with monocular viewing with each eye at each of three gaze eccentricities determined by the experimental placement of the fixated visual target (12.5 degrees to the left of primary position, primary position, and 12.5 degrees to the right of primary position).

Figure 7 shows the results for one normal observer (MR, upper left panel; measurements were made at 5 gaze eccentricities in his case) and three strabismics; the figure plots the location of the matched sounds against the eccentricity of the fixated visual target, with the main diagonal indicating the focus of veridical settings. Table I shows a characterization of the 21 strabismics for whom we have at least complete preoperative data (each of these strabismics was operated on and most were available for postoperative testing -- see below).

Figure 8 shows the match at each of the three gaze eccentricities for each of the ten comitant strabismics on whom complete pre- and postoperative measurements were made. The main diagonal plots the prediction from the model with unitary binocular EEPI (difference in localizations between the two eyes should be equal to the strabismic deviation). The dashed horizontal line plots the prediction from the model with independent and different monocular EEPI for each eye. The results fall along a best fit line with a slope of +.22, very far from the unitary EEPI model. Further indication of the failure of the results to support the unitary EEPI model is the fact that there was no regular order to the localization errors at the three gaze eccentricities across observers. Difference between the two eyes in setting of a visual target to the median plane also showed no systematic relation to the magnitude of the strabismic deviation (best-fitting slope = +.05).

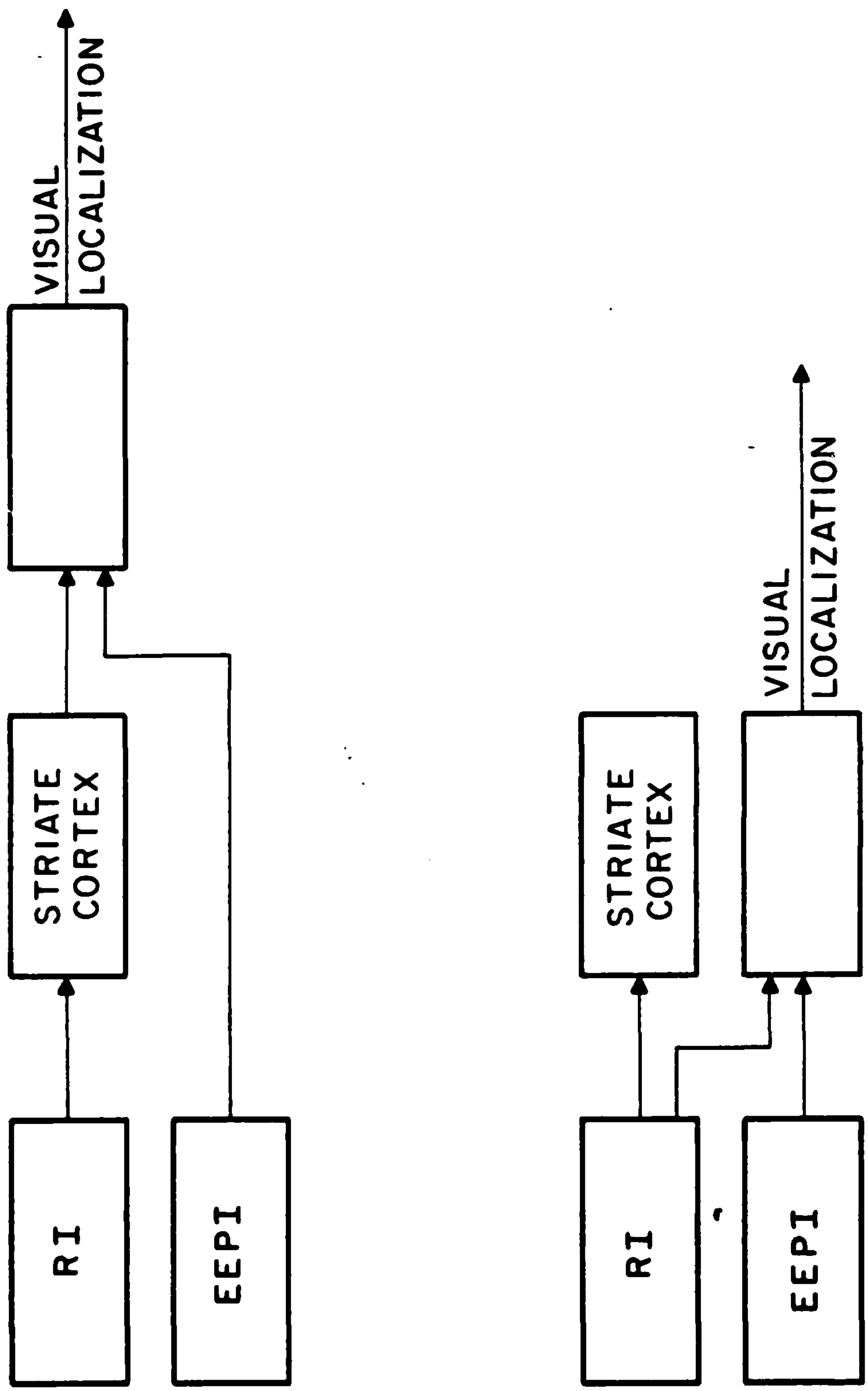
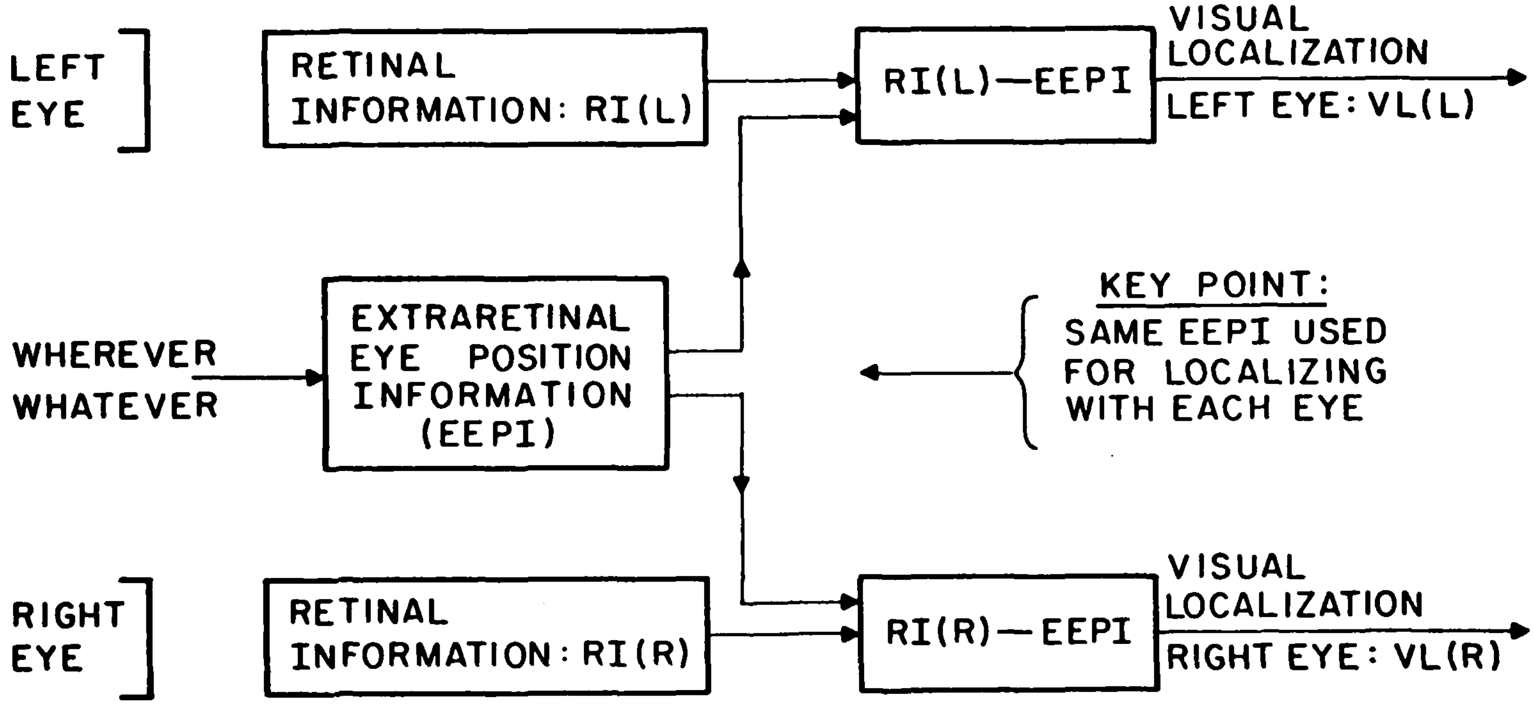


Figure 4. Two Possible Neural Circuits By Which Cancellation Is Mediated

LOCALIZATION WITH UNITARY BINOCULAR EEPI



IF RI(L) ≠ RI(R), THEN VL(L) ≠ VL(R).

SPECIFICALLY: RI(L) − RI(R) = VL(L) − VL(R).

Figure 5(a). Cancellation With Unitary Binocular EEPI

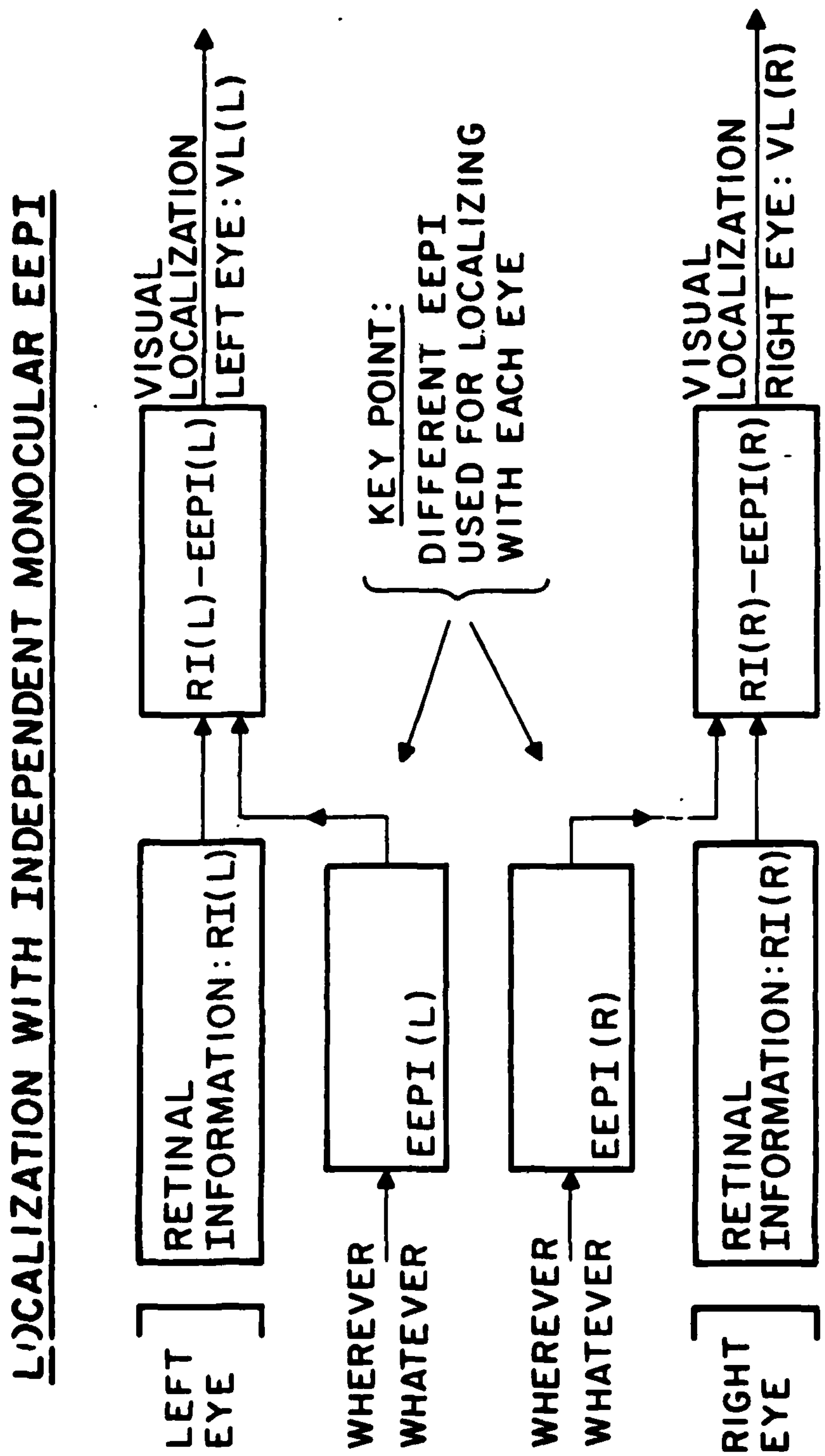


Figure 5(b). Cancellation With Independent Monocular EEPI

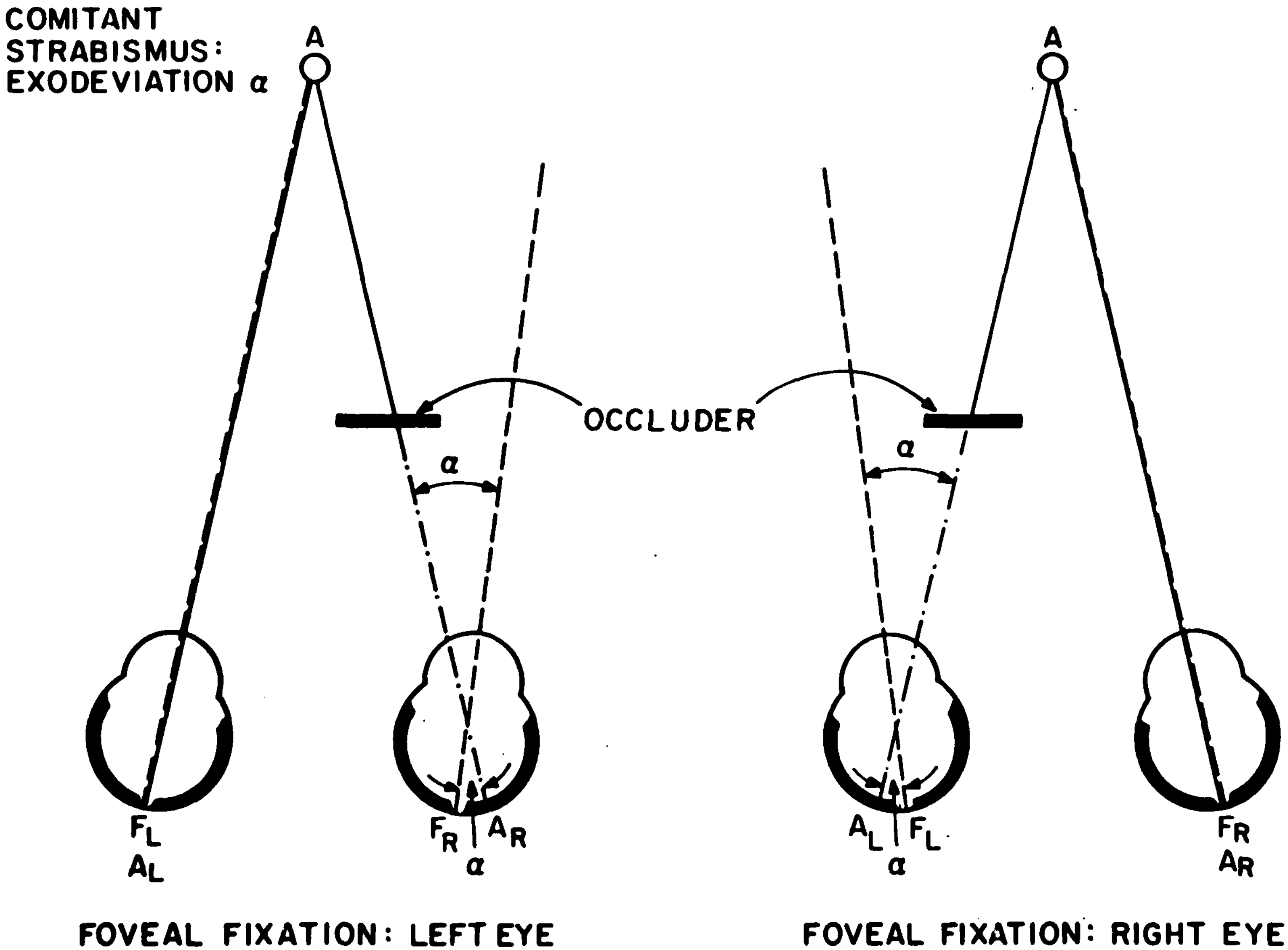


Figure 6. A Strabismic Observer Monocularly Fixates A Visual Target With His Left Eye On The Left Side Of The Figure, And With His Right Eye On The Right Side Of The Figure

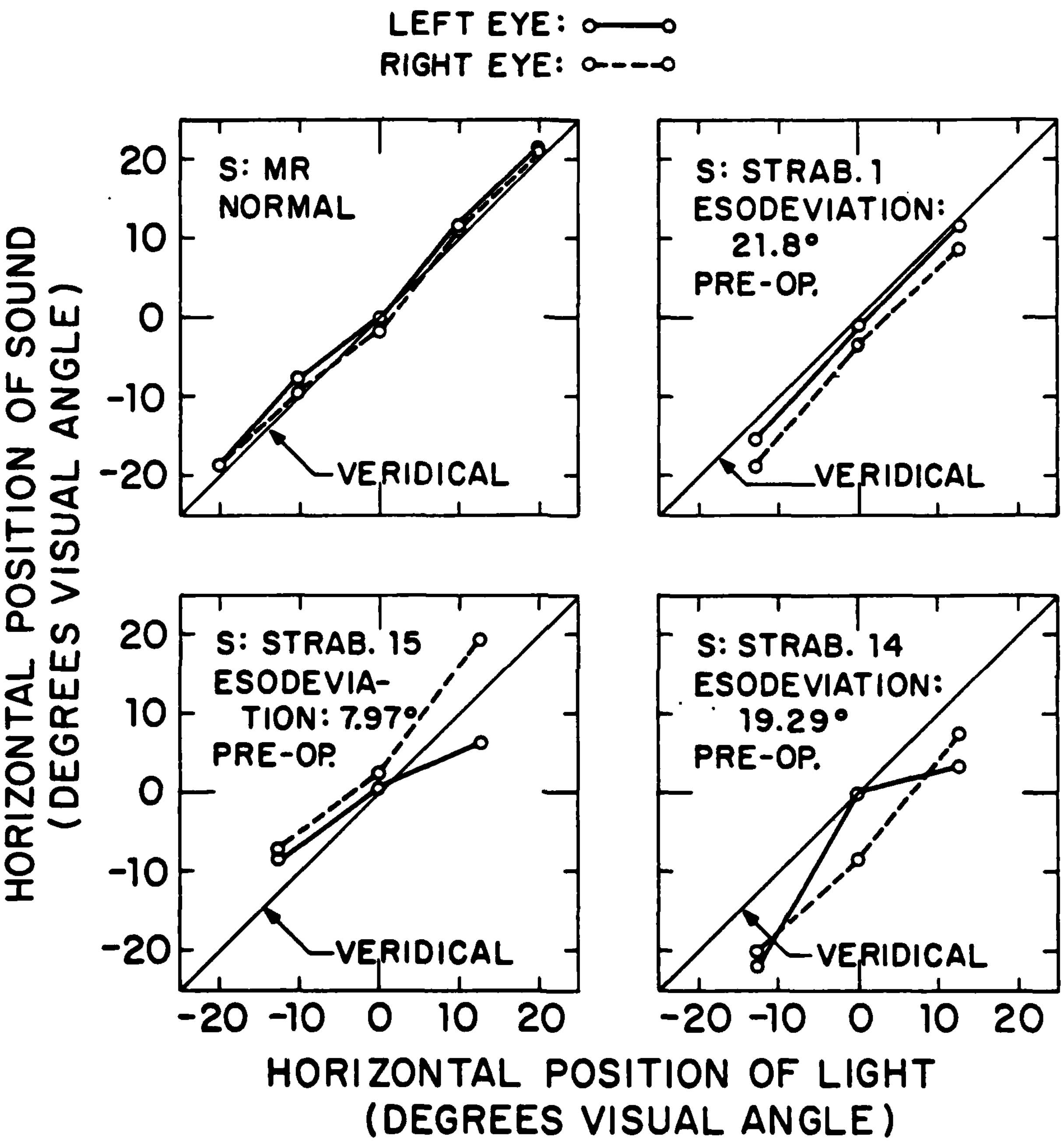


Figure 7. Match Of Horizontal Location Of A Sound To Location Of A Foveally Fixated Light For Each Eye Separately Viewing Monocularly For Each Three Strabismic Observers At Each of Three Gaze Eccentricities And One Normal Observer At Each Of Five Gaze Eccentricities

Table 1. Characteristics Of The 21 Strabismic Observers

n = 21

OPERATION		DEVIATION	COMITANCE	
			COMIT.	INCOMIT.
ONE EYE		ESO	4	1
		EXO	3	2
BOTH EYES		ESO	4	1
		EXO	3	1
		MIXED	–	2

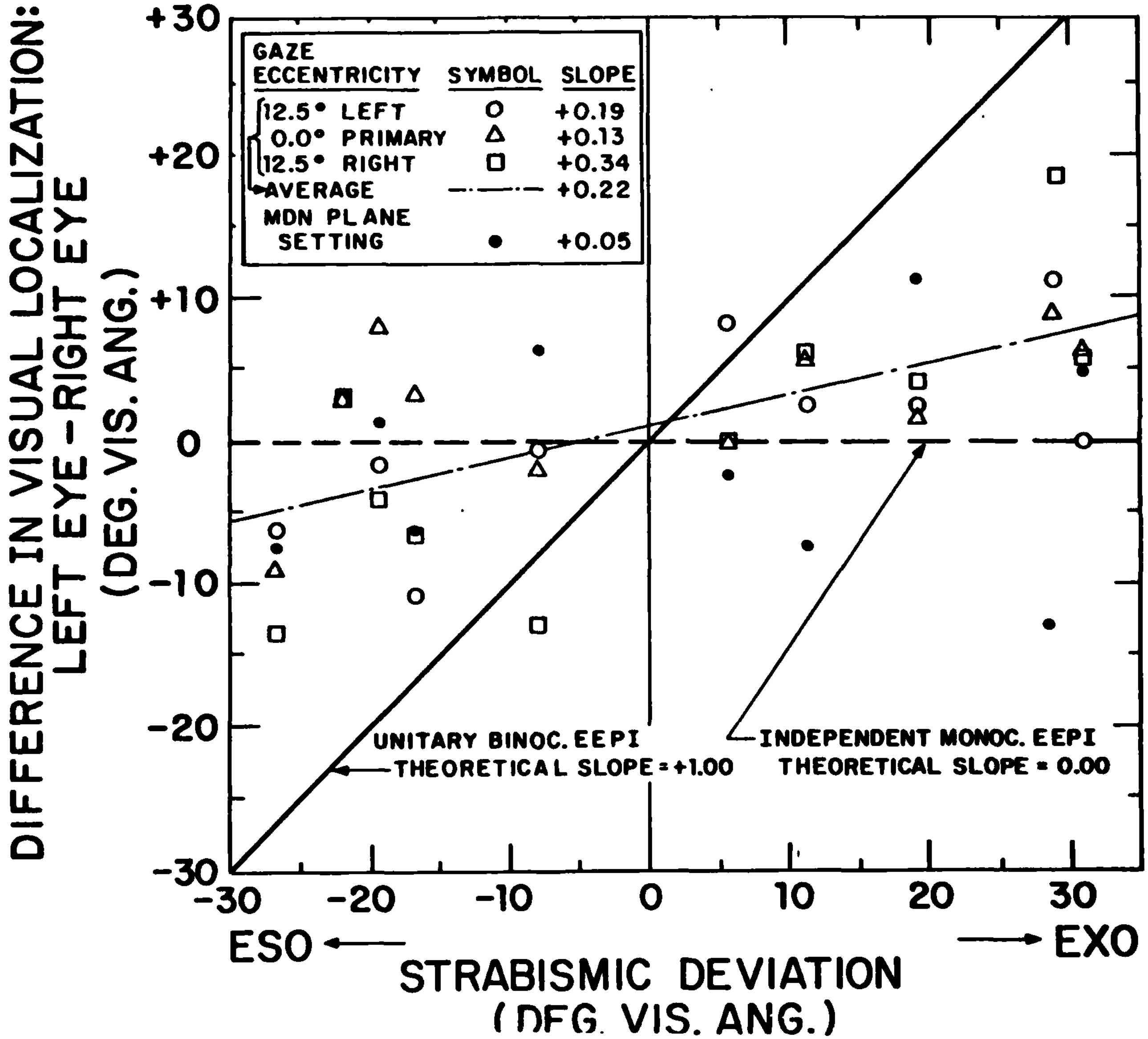


Figure 8. Preoperational Results For 10 Comitant Strabismic Observers, Showing The Left-Right Eye Difference In Localization Plotted Against The Magnitude Of The Strabismic Deviation.

Figure 9 repeats Figure 7 but also adds the postoperative results for the three strabismic observers. The postoperative results were obtained within 48 hours following the strabismic surgery. Postoperative measurements are not systematically different from the preoperative measurements for the strabismic observers in Figure 9; nor were systematic differences obtained for any of the other operated strabismics. Figure 10 displays the change in the difference in localization (change in left eye-right eye difference). The change was not systematically related to the original strabismic deviation (slope = -.03) which itself was approximately equal to the surgically produced ocular position change. These results either imply the operation of an inflow mechanism or a rapid recalibration of EEPI. I strongly believe that rapid recalibration has occurred; this does not at all, however, say anything about the presence or absence of an inflow mechanism.

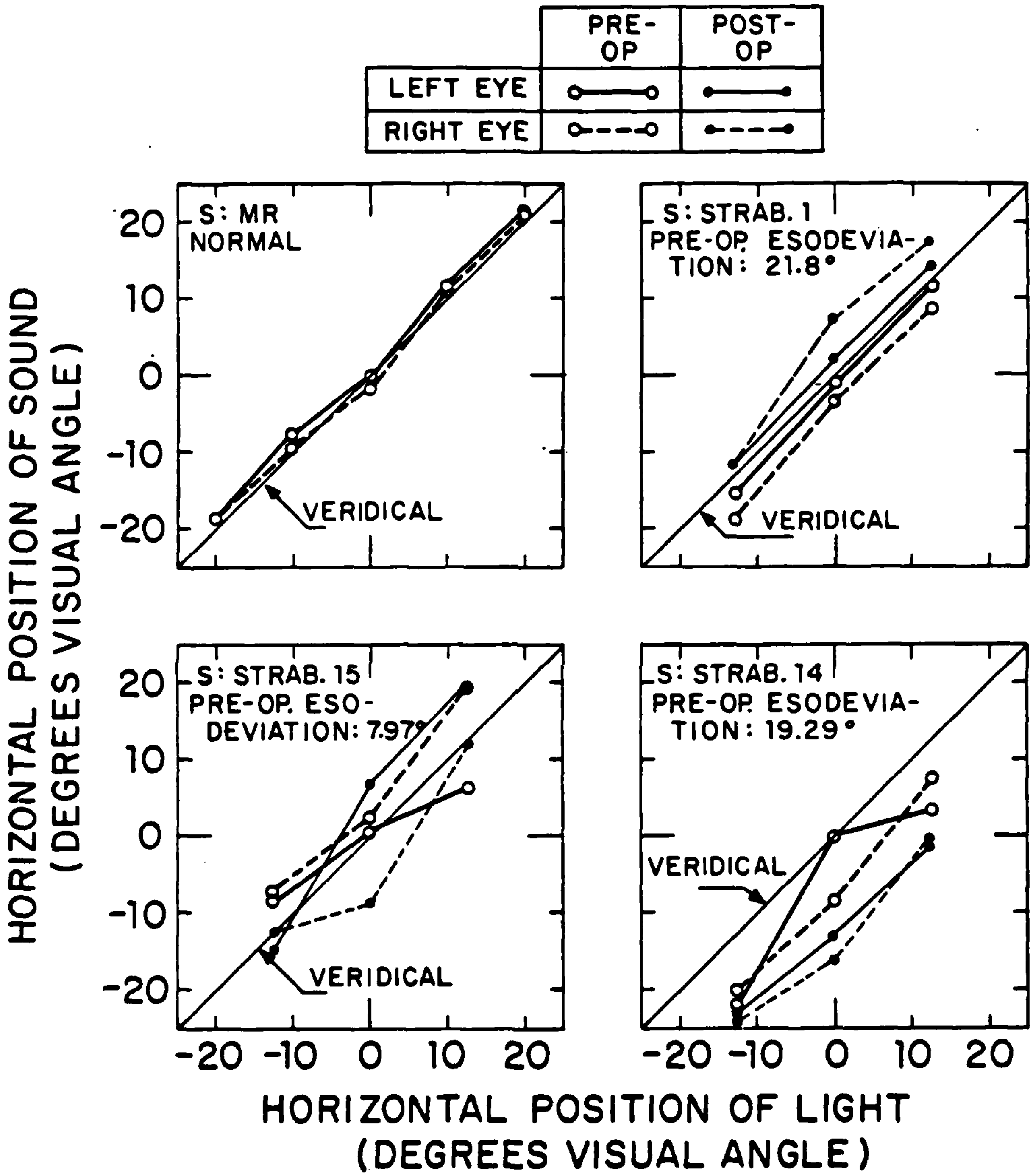


Figure 9. Same As Figure 7, But Also Shows The Postoperative Measurements For Each Eye

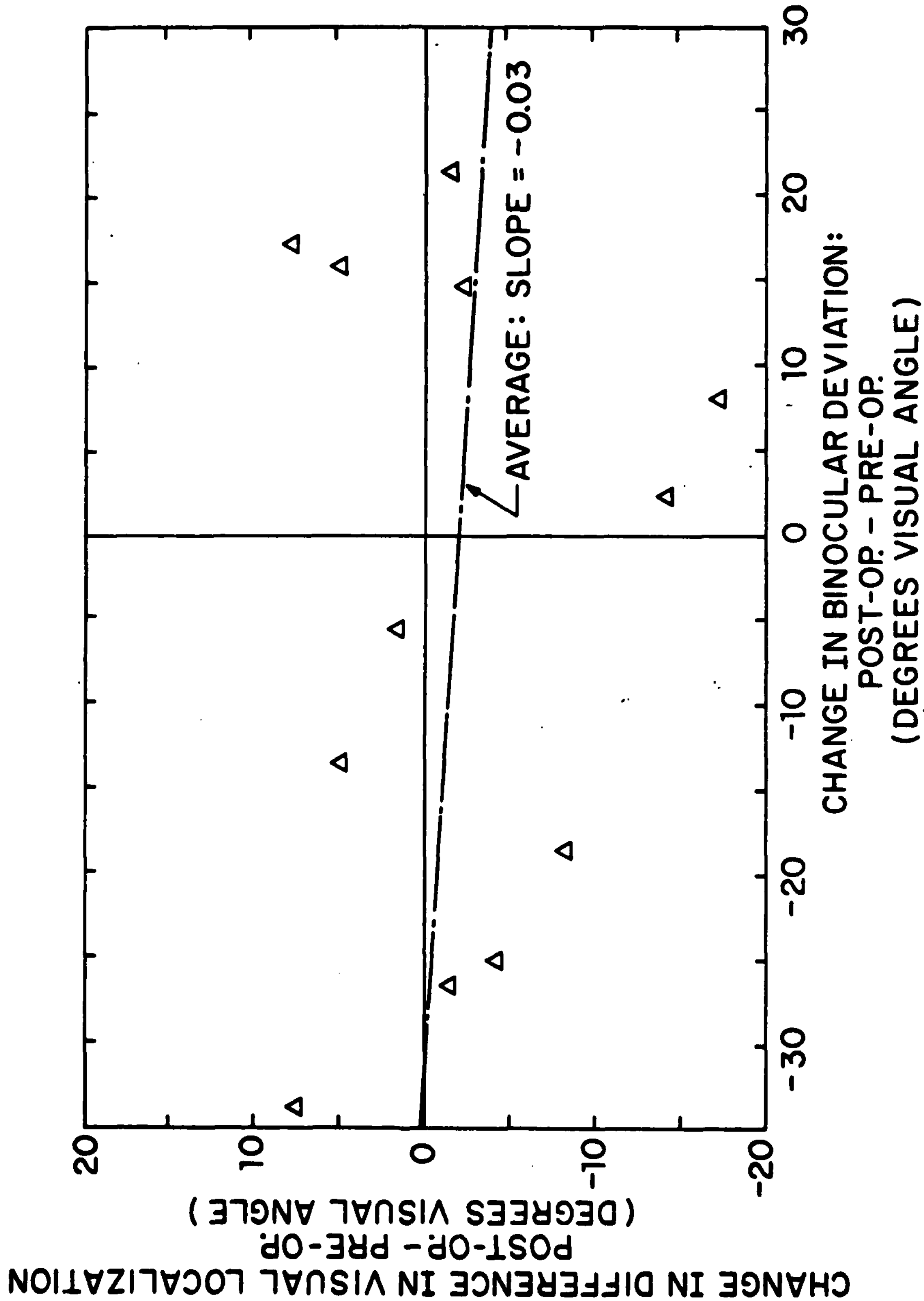


Figure 10. Postoperative Minus Preoperative Difference In the Left-Right Eye Difference In Localization Plotted Against The Preoperative Strabismic Deviation

REFERENCES

Matin, L. (1982a). Visual and auditory localization: normal and abnormal relations. Final Technical Report, for N62269 81C 0731, July, 1982.

Matin, L. (1982b). Visual Localization and Eye Movements in: Tutorials on Motion Perception. A Wertheim, W. A. Wagenaar, and H. W. Leibowitz (eds.) Plenum, New York, pp. 101-156.

Matin, L., Picoult, E., Stevens, J., Edwards, M. Jr., Young, D., and MacArthur, R. (1982). Oculo-paralytic illusion: visual-field dependent mislocalizations by humans partially paralyzed with curare. SCIENCE, 216, 198-201.

Matin, L., Stevens, J., and Picoult, E. (1983). Perceptual consequences of experimental extraocular muscle paralysis in: Hein, A. and Jeannerod, M. (eds.), Springer-Verlag, New York, pp. 243-262.

Rogan, M., Eggers, H. and Matin, L. (1983). Pre- and postoperative visual localization by strabismic observers. Invest. Ophthalm. and Vis. Sci. (Suppl.), 24, 83.

Matin, L. (1983). Interaction of EEPI and visual frameworks in the determination of visual and intersensory localization presented at Symposium: Spatial Localization and the Oculomotor System Invest. Opthalm. and Vis. Sci. (Suppl.), 24, 83.

	No. of Copies
Commander, Naval Safety Center, Naval Air Station, Norfolk, VA 23511	1
Commander, Naval Air Test Center, Patuxent River, Md 20670	1
Air Force Aerospace Medical Research Lab., AMRL/DAL Library, Wright-Patterson Air Force Base, OH 45433	2
Air University Library, Maxwell Air Force Base Montgomery, AL 36122	1
Headquarters, TAC/SPGA, Langley Air Force Base, Hampton, VA 23665	1
Science & Technology Div., Library of Congress, 110 2nd St., S.E. Washington, DC 20540	1
Dr. James A. Bynum, US Army AMRL, P.O. Box 476 Fort Rucker, AL 36362	1
LTC John K. Crosley, US Army AMRL, Fort Rucker, AL 36362	1
Dr. Siegfried Gerathewohl, Federal Aviation Administration Washington, DC 20591	1
Dr. John J. O'Hare, Office of Naval Research, Code 442, Arlington, VA 22217	1
Ms. Helen Paulsen, USN Submarine Base, Box 900, Groton, CT 06340	1
Dr. Lawrence Stark, 226 Minor Hall, University of California, Berkeley, CA 94720	1
Mr. Dennis Breglia, Naval Training Equipment Center, Code N-731, Orlando, FL 32813	1
Mr. John H. Allen, Naval Training Equipment Center, Code N-731, Orlando, FL 32813	1
Dr. Jeremiah Nelson, Dept. of Opthalmology, PHL 811, New York University Medical Center, 550 First Avenue, New York, NY 10016	1
Prof. Aaron Lewis, School of Applied and Engineering Physics, Cornell University, Ithaca, NY 14853	1
Dr. Myron L. Wolbarsht, Department of Ophthalmology, Duke University Medical Center, Durham, NC 27710	1

DISTRIBUTION LIST

NADC-83049-60

CONTRACT NO. N62269-82-M-3208

	No. of Copies
Director, Defense Technical Information Center, Bldg. 5, Cameron Station, Alexandria, VA 22314	12
Chief of Naval Operations (OP-98E) Navy Department, Washington, D.C. 20350	1
Chief of Naval Research, 800 N. Quincy St., Arlington, VA 22217 (1 for Code 440) (1 for Code 441)	2
National Library of Medicine, Bethesda, MD 20014	1
Commanding Officer, Naval Medical Research and Development Command, National Medical Center, Bethesda, MD 20014 (3 for Code 71) (3 for Code 7113) (1 for Code 7130) (2 for Code 42)	9
Commanding Officer, Naval Aerospace Medical Research Laboratory, Naval Air Station, Pensacola, FL 32508	2
Commanding Officer, Naval Aerospace Medical Institute, Naval Air Station, Pensacola, FL 32508	1
Commander, Operational Test & Evaluation Force, Naval Base, Norfolk, ' A 23511	1
Commanding Officer, Naval Training Equipment Center, Orlando, FL 32813	2
Commanding Officer, Naval Submarine Medical Center, Naval Submarine Base, New London, Groton, CT 06340	1
Commander, Naval Air Systems Command, Washington, DC 20361 (00D4) (2 for retention) (8 for AIR-320R) (1 for AIR-340B) (1 for AIR-531) (1 for AIR-5311C) (1 for AIR-5313)	14
Commanding Officer, Naval Health Research Center, P.O. Box 85122, San Diego, CA 92138	1
Commanding Officer (3 for 8131) (6 for 60B1)	9

DAT

ILM